

# **Resources and Tools to Reduce Multiple Risky Driving Behaviors**

## Task 1 Report

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# 1 INTRODUCTION

There is growing recognition that drivers involved in fatal crashes are often engaged in multiple risky behaviors – not wearing a seat belt, speeding, and driving impaired (FARS, 2018). To reach our collective goal of zero deaths on our nation’s roadways, we must seek to understand factors associated with multiple risky driving behaviors and then develop and test interventions that can effectively reduce these risky driving behaviors and improve overall driving safety.

This report summarizes Task 1 of this project. The purpose of Task 1 is to conduct a literature review of published research to:

- Understand the multifaceted nature of impulsivity (what impulsivity is, kinds of impulsivity, etc.), how impulsivity is measured, and the relationship between impulsivity and high-risk driving behaviors.
- Review other factors like sensation seeking, affinity for risk, risk awareness, and substance use disorders as these factors may be important in the development of an intervention that addresses multiple risky driving behaviors.
- Explore ways to reduce impulsivity and other factors associated with multiple risky driving behaviors.
- Inform the development of a successful intervention that influences multiple risky driving behaviors.

In addition to a review of literature, this Task 1 report includes two outlines that support the development, implementation, and evaluation of a brief intervention designed to reduce multiple risky driving behaviors. The outlines included are a curriculum outline and an implementation and evaluation plan outline.

## 2 BACKGROUND

According to the Fatality Analysis Reporting System (FARS), from 2014 to 2018 there were over 10,350 drivers involved in fatal crashes who were simultaneously unrestrained, speeding, and under the influence of alcohol (FARS, 2018). Drivers engaging in multiple risky behaviors (such as not using a seat belt, speeding, and driving impaired) may require more intensive interventions than are typically provided to drivers who are cited for any one of these risky behaviors in isolation.

Research evidence suggests there are associations between multiple risky driving behaviors (Simons-Morton et al., 2016; Li et al., 2013). For example, one study revealed that risky drinking was associated with risky driving behaviors among youth (e.g., driving under the influence of alcohol, speeding, tailgating, talking on a cell phone, sending text messages, etc.) and recommended addressing them in combination as these behaviors may be linked by similar underlying belief systems like the affinity for risk or impulsiveness (Simons-Morton et al., 2016). Another study found low risk perception and high impulsivity were significant risk factors for a variety of risky behaviors such as infrequent seat belt use, drinking and driving, riding with an impaired driver, binge drinking, and speeding for the thrill, among patients at a trauma center who had experienced unintentional blunt trauma (Ryb et al., 2006). Similarly, among people with driving violations, impulsivity was associated with both impaired driving and exceeding speed limits (Paaver et al., 2006).

Impulsivity influences various risky driving behaviors (Bicaksiz & Ozkan, 2016b). Traffic impulsivity is defined as “the tendency to act quickly and inaccurately or act quickly and accurately without considering and elaborating on the future consequences while driving” (Bicaksiz & Ozkan, 2016b, p. 220). Traffic impulsivity “may involve the inability to wait in traffic, expressing anger and aggression to others while driving, speeding, using a cell-phone while driving, close following, and making sudden accurate or inaccurate maneuvers without considering consequences” (Bicaksiz & Ozkan, 2016b, p. 220).

While the association between impulsivity and various risky driving behaviors is established in the literature, there is a gap in understanding how to address impulsivity and the underlying beliefs and behaviors of individuals engaging in multiple risky driving behaviors. The proposed research seeks to address this gap by creating and testing an intervention designed to reduce traffic impulsivity to improve driver behaviors.

A review of the Transportation Research International Documentation database revealed that interventions designed to address traffic impulsivity to improve driver behaviors are limited. Two studies were found that focused on the same brief intervention addressing impulsivity and driving behaviors with young novice drivers (Paaver et al., 2013; Eensoo et al., 2018). Researchers found the brief intervention improved traffic behavior for novice drivers in the initial study. After participating in the initial intervention, the researchers conducted a follow-up study and tracked traffic violations and traffic crashes for a period of four years. Results from this follow-up study revealed that the benefits of participating in the intervention remained;

“speeding, drunk driving, and involvement in traffic accidents were significantly lower in the intervention group” (Eensoo et al., 2018, p. 19). These findings suggest that brief interventions focused on impulsive behavior may be an important strategy to address multiple risky driving behaviors.

While the proposed brief intervention focuses on traffic impulsivity, it is also important to recognize that traffic impulsivity is not the only factor influencing multiple risky driving behaviors. Other underlying beliefs and behaviors such as sensation seeking, affinity for risk, and risk awareness may also be involved. In addition, research shows that drivers with multiple incidences of impaired driving often have a substance use disorder (LaPlante et al., 2008). Therefore, an intervention that seeks to address multiple risky driving behaviors may need to include elements of screening and referral to treatment.

Characteristics such as psychological reactance may also influence the decisions of drivers engaging in multiple risky driving behaviors. An intervention will likely need to address this characteristic. This project can utilize previous research that has been done by the Traffic Safety Culture Pooled Fund to decrease reactance (Otto et al., 2021). Designing an intervention with these factors and characteristics in mind will be important to address multiple risky driving behaviors.

### 3 METHODS

To obtain research articles for this review, a keyword search was conducted using databases that cover published academic research (e.g., Google Scholar, TRID database and Montana State University Library search engines Academic Search Complete and EBSCO). The search was limited to peer-reviewed and publicly available literature published in English after 2000.

Word search and phrase combinations included: “high-risk driving behaviors,” “factors associated with unsafe driving,” “personal risk recognition,” “driving risk perception,” “multiple risky driving behaviors,” “traffic impulsivity,” “impulsivity and driver behavior,” “impulsivity scales,” “impulsiveness and driving,” “brief interventions,” “seat belt intervention,” “distracted driving intervention,” “impaired driving intervention,” and “behavioral traffic interventions.”

Once articles were reviewed for relevance, additional key words were used in combination to narrow the search. Additionally, the reference lists of relevant articles were reviewed for other potentially relevant articles that may have been missed with the key word searches.

After a review of available search engines, we chose to use Research Rabbit, which is a new search platform with smart functions to construct, apply, and organize literature services. For example, this platform automatically sends email updates about new literature that has been published on specific topics of interest. Research Rabbit uses Microsoft Academic as its primary search engine, which is a new tool for conducting literature reviews that uses algorithms based on artificial intelligence. As an example, its searches are based on the semantic meaning of chosen keywords rather than just the specific words used.

## 4 RESULTS

High-risk drivers make up approximately 6% of the driving population but account for a disproportionate number of crashes and near crashes (Guo & Fang, 2012). Research findings suggest that the consequences associated with high-risk driving (i.e., driving violations, traffic crashes, traffic injuries and fatalities) are substantial (Dahlen et al., 2005; Oltedal & Rundmo, 2006). There is growing recognition that drivers involved in fatal crashes are often engaged in multiple risky behaviors – not wearing a seat belt, speeding, and driving impaired (FARS, 2018). Those engaging in multiple risky driving behaviors may require more intensive or different interventions than are typically provided to drivers who are cited for any one of these risky behaviors in isolation. To reach our collective goal of zero deaths on our nation’s roadways, we must seek to understand factors associated with multiple risky driving behaviors and then develop and test interventions that can effectively reduce these risky driving behaviors and improve overall driving safety.

In this review of literature, several factors associated with multiple risky driving behaviors are reviewed. One such factor that is of particular interest is impulsivity. Impulsivity is a primary focus because it is a factor amenable to change and is a trait that overlaps and is associated with other factors that affect risky driving (Al-Tit, 2020). While impulsivity is the primary focus of this review of literature, other salient cognitive, affective, motivational, and contextual factors associated with multiple risky driving behaviors are also reviewed.

### 4.1 Impulsivity

Impulsivity is broadly viewed as “the inability to withhold or stop a response in the face of negative consequences; preference for a small immediate reward versus a larger but delayed one; acting without forethought or before all necessary information is available; novelty/sensation - seeking and an increased propensity to engage in risky behaviors” (Bari et al., 2011, p. 380-381). Other definitions include a tendency toward quick and unplanned reactions without considering consequences to oneself or others (Dickman, 1990; Moeller et al., 2001) and the tendency to display maladaptive behaviors and impaired decision making (de Wit, 2009).

Impulsivity is considered a multidimensional construct (Stanford et al., 2009; Bari et al., 2011). However, consensus on what dimensions of impulsivity are of most interest has not been reached and varies from study to study (Bicaksiz & Ozkan, 2016b; Kocka & Gagnon, 2014). For example, Barratt (1985) identified three dimensions of impulsiveness: motor impulsiveness -- the tendency to act without thinking; cognitive impulsiveness – the sub trait of making quick decisions; and non-planning impulsiveness – the inability to plan ahead, a lack of forethought. Whiteside and Lynam (2001) suggested four distinct psychological processes that lead to impulsive behavior including urgency, lack of premeditation, lack of perseverance, and sensation seeking. Urgency refers to the “tendency to commit rash or regrettable actions as a result of intense negative affect” (Whiteside & Lynam, 2001, p. 677). Lack of premeditation refers to the tendency to not deliberate or carefully think about the consequences of one’s actions before engaging in the action (Whiteside & Lynam, 2001). Lack of perseverance refers to the inability

to “stay with a task until completion and avoid boredom” (Whiteside & Lynam, 2001, p. 677). Sensation seeking refers to the “tendency to seek excitement and adventure” (Whiteside & Lynam, 2001, p. 677). The dimensions of interest in understanding the concept of impulsivity vary; however, some commonly identified subcomponents of impulsivity have emerged including behavioral inhibition, impaired decision making, risk taking, and impaired planning (Bari et al., 2011; Bicaksiz & Ozkan, 2016b).

Because impulsivity has been conceptualized to include various dimensions of behaviors, it is not surprising that specific measures of impulsivity have been developed to account for this variation. Table 1 lists some of the most common impulsivity measures.

**Table 1. Examples of Impulsivity Measures**

Measurement Constructs	Dimensions of Impulsive Behavior (Impulsivity Subscales)	Source
I-7 Impulsiveness Questionnaire	Impulsiveness, Venturesomeness, and Empathy	Eysenck et al., 1985
I-5 Impulsiveness Questionnaire	Narrow Impulsivity, Risk Taking, Liveliness, and Non-Planning	Eysenck & Eysenck, 1977
Barratt Impulsiveness Scale (BIS-11)	Attentional Impulsiveness, Motor Impulsiveness, and Non-Planning Impulsiveness	Patton et al., 1995
Impulsive driver behavior scale (IDBS)	Urgency, Lack of Premeditation, Lack of Perseverance, and Functional Impulsivity	Bicaksiz & Ozkan, 2016a
EASI-III Impulsivity Scales	Inhibitory Control, Decision Time, Sensation Seeking, and Persistence	Buss & Plomin, 1975 as found in Griffin et al., 2018
Dickman’s Functional and Dysfunctional Impulsivity Scales	Functional Impulsivity and Dysfunctional Impulsivity	Dickman, 1990

Impulsivity is generally viewed as counterproductive and maladaptive. However, it has been argued that impulsivity is not always negative but can be beneficial in some situations (Dickman, 1990). Categorizing impulsivity into two types, dysfunctional and functional, can account for this variation and result in a fuller understanding of the concept (Dickman, 1990). Dysfunctional impulsivity “represents the tendency to engage in rapid, error-prone information processing because of an inability to use a slower, more methodical approach” (Dickman, 1990, p. 101). Dysfunctional impulsivity might look like saying or doing something without thinking through the consequences or deciding without considering options that might be available. The consequences of dysfunctional impulsivity are generally negative and associated with personality traits like disorderliness and lack of concern for facts (Dickman, 1990). In contrast, functional

impulsivity “represents the tendency to engage in rapid, error-prone information processing (i.e., to act with relatively little forethought) when such a strategy is rendered optimal” like in situations that require quick decision making and immediate action (Dickman, 1990, p. 101). For example, impulsivity may be optimal in a situation where a time limited opportunity is presented and without a quick decision, one would lose their chance to take advantage of the opportunity. Functional impulsivity is associated with other personality traits like enthusiasm and adventurousness and is generally viewed as a positive trait (Dickman, 1990).

#### 4.1.1 Impulsivity in the Context of Traffic Safety

Impulsivity is a relevant concept to understanding behaviors in various contexts (Stanford et al., 2009; Bari et al., 2011). According to Bicaksiz and Ozkan (2016a), “driving is one of the contexts where impulsivity can be expressed because of its self-paced nature (i.e., a driver usually decides how to act in traffic). Hence, investigation of impulsivity in the driving context has a potentially important role in the explanation of driver behaviors” (p. 339).

Impulsivity in the context of traffic safety has been termed “traffic impulsivity” (Bicaksiz & Ozkan, 2016b). Traffic impulsivity is defined as

the tendency to act quickly and inaccurately or act quickly and accurately without considering and elaborating on the future consequences while driving. Specifically, it may involve the inability to wait in traffic; expressing anger and aggression to others while driving; speeding; using cellphone while driving; close following; and making sudden accurate or inaccurate maneuvers without considering consequences. (Bicaksiz & Ozkan, 2016b, p. 220)

Researchers commonly agree that impulsivity is a personality construct associated with high-risk driving behaviors (e.g., speeding, following too closely, driving while impaired) and negative outcomes associated with high-risk driving including aberrant driver behaviors, driver anger/aggression, driving under the influence of alcohol, traffic crashes, and traffic violations (Hatfield et al., 2017; Bicaksiz & Ozkan, 2016b; Gonzalez-Iglesias, 2012; Beanland et al., 2014; Eensoo et al., 2010; Paaver et al., 2006; Hatfield et al., 2017). Drivers categorized as having more risky driving behaviors score higher on impulsive behaviors than those categorized as having safe driving behaviors (Barati et al., 2020).

Studying impulsivity as a multidimensional construct versus a unidimensional one is key to understanding behaviors and their associated outcomes within the driving context. In a study examining the effects of five impulsivity-like traits (premeditation, perseverance, sensation seeking, negative urgency, and positive urgency) on driving outcomes (including: driving errors, lapses, violations, use of a cell phone while driving, traffic citations, and traffic collisions), Pearson et al. (2013) found all five impulsivity traits were related to multiple risky driving outcomes, although there were distinct relationships between the different traits and outcomes. Positive urgency, or the tendency to act impulsively when experiencing positive feelings, was the strongest predictor of risky driving outcomes in this study (Pearson et al., 2013). Positive urgency was “significantly associated with driving errors, driving lapses, and driving violations” (Pearson et al., 2013, p. 146). Similarly, negative urgency (the tendency to act impulsively when

experiencing negative feelings) was also significantly associated with these three driving outcomes and was additionally associated with using a cell phone while driving (Pearson et al., 2013). Premeditation “was significantly negatively correlated with driving errors, driving violations, and cell phone driving” (Pearson et al., 2013, p. 146). Sensation seeking was only related to certain unsafe driving behaviors, specifically, driving violations and cell phone driving (Pearson et al., 2013).

Studying both dysfunctional and functional impulsivity in the driving context is insightful as they have different relationships with different driver behaviors (Bicaksiz & Ozkan, 2016b; Bicaksiz et al., 2019; Paaver et al., 2006). Paaver et al. (2006) found, in general, high-risk drivers had higher scores in both functional and dysfunctional impulsivity; however, the expression of both subtypes (functional and dysfunctional) of impulsivity were different among different behaviors. For example, drunk driving was associated with maladaptive types of impulsivity, and exceeding speed limits was associated with functional impulsivity and to a lesser degree dysfunctional impulsivity (Paaver et al., 2006). Likewise, dysfunctional impulsivity has shown to be associated with errors and lapses, whereas functional impulsivity has shown to be negatively associated with errors and lapses (Bicaksiz & Ozkan, 2016a). These results indicate that understanding the nuances inherent in the conceptualization of impulsivity may be important in considering interventions that influence the behaviors of people engaging in multiple risky driving behaviors.

## **4.2 Other Factors Associated With Multiple Risky Driving Behaviors**

Other salient factors associated with multiple risky driving behaviors include cognitive factors, affective factors, motivational factors, and contextual factors. Many of these factors that affect risky driving must be considered in combination as they overlap and are related to one another (Al-Tit, 2020; Bachoo et al., 2013; Iversen & Rundmo, 2002). An intervention that seeks to address multiple risky driving behaviors may need to consider the influence of these factors. Table 2 provides an overview of the factors that are associated with specific high-risk driving behaviors. The factors examined here are not comprehensive, but they represent factors commonly identified in relationship to multiple risky and unsafe driving behaviors.

### **4.2.1 Cognitive Factors**

Cognitive factors commonly associated with multiple risky driving behaviors include sensation seeking and risk perceptions.

#### **4.2.1.1 Sensation Seeking**

Sensation seeking has been defined as “a trait characterized by the pursuit of novel, diverse, and extreme experiences” (Hennessy, 2011, p. 150). Some researchers have categorized sensation seeking as a subdimension of impulsivity (Eysenck and Eysenck, 1977); other researchers have argued that impulsivity and sensation seeking are distinct constructs (Bicaksiz & Ozkan, 2016b). Cheng et al. (2012) suggested that even though impulsivity and sensation seeking are similar concepts, what motivates risk-taking behavior is different. Their research revealed that “a high level of sensation seeking leads to risk-taking behavior because of the thrill it provides, whereas

impulsivity has the same consequences but for different reasons; the individuals simply lack the self-control to refrain from engaging in high-risk activity” (Cheng et al., 2012, p. 597).

A large body of literature has studied sensation seeking and its relationship with risky driving behaviors and consequences (Akbari et al., 2019; Bachoo et al., 2013; Iversen & Rundmo, 2002; Al-Tit, 2020; Dahlen & White, 2006). In a systematic review of literature of 40 studies, only four did not find a significant association between sensation seeking and some aspect of risky driving including speeding, unsafe passing, and drinking and driving (Jonah, 1997, p. 660). In a recent meta-analysis, Akbari et al. (2019) found significant positive relationships between risky driving behaviors and sensation seeking. Other risky driving behaviors and consequences linked to sensation seeking include ignorance of traffic rules (Iversen & Rundmo, 2002) and moving citations and traffic crashes (Dahlen & White, 2006). Further, research has found that those high in sensation seeking perceive risky driving behaviors to be less dangerous than those with lower sensation seeking scores (Jonah, 1997).

In considering sensation seeking as a factor associated with multiple risky driving behaviors, Hennessey (2011) suggested that caution must be taken as much of the traffic safety literature regarding risky and unsafe driving tends to focus on younger drivers who lack driving experience and who developmentally are primed for added risk taking compared to older adults. Thus, because sensation seeking is strongly associated with age and other developmental variables, the construct of sensation seeking and its relationship with risky and unsafe driving may be inflated (Hennessey, 2011).

#### **4.2.1.2 Risk Perceptions**

Risk perceptions can be defined as “the subjective experience of risk in potential traffic hazards” (Deery, 1999, p. 226 as found in Machin & Sankey, 2008, p. 542). Risk perception can be categorized into cognitive-based risk perceptions also known as “rational” risk perceptions and emotion-based risk perceptions also known as “affective” risk perceptions (Rundmo & Iversen, 2004). Cognitive-based risk perceptions include how a person perceives and processes information in traffic safety (Rundmo & Iversen, 2004), for example, how probable one perceives a traffic crash to be or how risky one assesses speeding on specific road conditions to be. Emotion-based risk perceptions include feelings related to thinking about traffic-related risks (Rundmo & Iversen, 2004). Affective risk perceptions include feelings like fear, anxiety, worry, excitement, irritation, and other emotional reactions that occur when assessing a potential traffic risk.

There is a large body of research that has studied perceived risk and its association with risky traffic-related behaviors (Ivers, et al., 2009; Dionne et al., 2007; Bingham et al., 2007). Low risk perceptions are associated with riskier traffic behaviors including impaired driving, infrequent seat belt use, and speeding (Dionne et al., 2007; Ryb et al., 2006). Li et al. (2021) found that risk perceptions and sensation seeking were influential in shaping truck drivers' intentions to engage in risky driving behavior with attitude being a mediating variable.

However, some research suggests that risk perceptions are a weak predictor of risk behavior (Ulleberg & Rundmo, 2003). While it seems as though increasing awareness of risks would

inherently lead to more accurate risk perceptions, some research suggests increasing awareness of risks may not be sufficient to change a person's risk perceptions (Falk & Montgomery, 2007). It may be necessary to heighten the cognitive and emotional awareness of the consequences of risky traffic behaviors to modify beliefs and change behavior (Falk & Montgomery, 2007).

#### 4.2.2 Affective Factors

Affective factors often associated with multiple risky driving behaviors include driving anger and aggression and the Big 5 personality factors (i.e., extraversion, agreeableness, neuroticism, conscientiousness, and openness).

##### 4.2.2.1 Driving Anger and Aggression

Driving anger and aggression and their relationship with high-risk driving behaviors have been studied frequently. Driving anger and aggressive driving are considered significant problems in traffic safety and are reflected in Strategic Highway Improvement Plans across the country. The concept of driving anger originated from studying problem anger in a wide range of settings and recognizing that situations like driving could trigger anger (Deffenbacher et al., 2016). Driving anger is defined as becoming angry while driving (Deffenbacher et al., 2016). Common triggers of driving anger include being slowed down or obstructed from progressing as expected (impedance), being put at risk by other drivers' unsafe behaviors, and encountering hostile or inconsiderate drivers (Deffenbacher et al., 2016). Impedance is the most common situation that evokes driving anger, but perceived discourtesy of other drivers often evokes the most anger (Deffenbacher et al., 2016).

Researchers suggest that those high in driving anger become angrier more often when driving and are more prone to evaluate the driving situation in a more hostile way than those with low driving anger (Deffenbacher et al., 2016). Further those scoring high on driving anger are more aggressive drivers and are at greater risk of negative consequences such as crashes and injuries (Deffenbacher et al., 2016). In a meta-analysis of risky driving behaviors and personality characteristics, Akbari et al. (2019) found a significant positive correlation between risky driving behaviors and driving anger.

Aggression in traffic has been conceptualized as “actions intended to physically, psychologically, or emotionally harm another within the driving environment” (Hennessey, 2011, p. 151). Aggression in traffic could look like “yelling, swearing, purposely tailgating, leaning on the horn, and roadside confrontations” (Hennessey, 2011, p. 151). Aggression has also been defined as “dangerous driving behaviors regardless of intent, such as speeding, weaving through traffic, and using the shoulder to pass” (Hennessey, 2011, p. 151).

Driving anger and aggression are often studied in combination with impulsivity (Dahlen et al., 2005; Mirón-Juárez et al., 2020). For example, poor impulse control is a common underlying trait of impulsivity; likewise, self-control is a key component of driving anger and its expression of that anger (Dahlen et al., 2005; Mirón-Juárez et al., 2020). Research suggests that drivers reporting higher impulsivity are also more likely to express anger while driving (Dahlen et al., 2005; Mirón-Juárez et al., 2020). Mirón-Juárez et al. (2020) found that “impulsivity had a moderate capacity to predict the degree of anger expressed by drivers” (p. 79). Berdoulat et al.

(2013) suggested that the three personality domains of “driving anger, aggressiveness and impulsiveness are involved in a complementary manner in the prediction of driving behavior, violations, and aggressive violations” (p. 765).

#### **4.2.2.2 Big 5**

The Big Five personality factors include extraversion, agreeableness, neuroticism, conscientiousness, and openness. In a meta-analysis of the correlation between personality characteristics and risky driving behaviors, significant relationships between risky driving behaviors and the big five personality factors were found (Akbari et al., 2019). For example, risky driving behavior had a negative relationship with agreeableness and a positive relationship with neuroticism (Akbari et al., 2019). In other words, individuals most likely to engage in risky driving behaviors are low in agreeableness, but high in neuroticism (Akbari et al., 2019). While these two personality factors were significantly related to risky driving, the results of this meta-analysis found no significant relationships between risky driving behavior and extraversion, conscientiousness, or openness (Akbari et al., 2019).

#### **4.2.3 Motivational Factors**

Motivational factors commonly associated with multiple risky driving behaviors include reward sensitivity and tolerance of deviance.

##### **4.2.3.1 Reward Sensitivity**

Sensitivity to punishment and reward is a motivational factor associated with risky driving behavior (Scott-Parker & Weston, 2017; Constantinou et al., 2011). Understanding the role of sensitivity to reward in traffic safety is new, although the idea that rewards motivate learning and behavior is not new. There is an abundance of literature in the field of psychology regarding the role of rewards and punishment in motivating and modifying behavior. Behaviors that are considered rewarding are more likely to be repeated, and behaviors that are considered punishing are less likely to be repeated (Scott-Parker & Weston, 2017, p. 94). In a synthesis of the literature regarding the role of reward sensitivity in risky driving and risky decision making, it was found that those with greater reward sensitivity were found to engage in risky driving behaviors, risky decision making, and other risky health-related behaviors more than individuals with lower reward sensitivity (Scott-Parker & Weston, 2017). With this factor in mind, interventions that rely on punitive consequences may not be as impactful for those who are less sensitive to punishment and may need to instead use strategies that find ways of rewarding positive and safe traffic behaviors for high-risk drivers (Constantinou et al., 2011; Scott-Parker & Weston, 2017).

##### **4.2.3.2 Tolerance of Deviance**

Tolerance of deviance is defined as “the acceptance of behaviors that most others consider wrong or immoral” (Shope, 2006, p. i10). People with a high tolerance of deviance (those who do not consider deviant behavior to be wrong) engage in more risk-taking driving behaviors (Patil et al., 2006) and have a higher probability of poor driving outcomes (Shope et al., 2003; Bingham & Shope, 2004).

#### 4.2.4 Contextual Factors

Contextual factors such as demographic variables, substance use behaviors, and psychological reactance are also included in this review of literature.

##### 4.2.4.1 Demographic Variables

The characteristics of high-risk drivers are well identified and include the group of drivers “who are young, inexperienced, and recidivists with higher crash rates than others” (Habtemichael & de Pacado-Santos, 2013, p. 307). Contextual factors that influence multiple risky driving behaviors like age and sex have been well documented. Young drivers have a crash rate that is three times higher per mile driven than drivers ages 20 and older (IIHS, 2021). Younger drivers have less experience at the driving task and perceive less risk in engaging in risky driving behaviors (Rhodes & Pivik, 2011). Gender differences are also found in literature on multiple risky driving behaviors (Patil et al., 2006). Males are more likely than females to engage in risky driving behaviors (Shope et al., 2001; Bachoo et al., 2013). Further, males have higher rates of traffic crashes (Shope et al., 2001). While age and gender are not modifiable factors, when developing interventions to reduce multiple risky driving behaviors, keeping strategies that can reach these demographics in mind may be important.

##### 4.2.4.2 Substance Use

Traffic safety research in the last quarter of 2020 found that 56% of drivers involved in serious injury and fatal crashes tested positive for at least one substance (National Highway Traffic Safety Administration [NHTSA], 2021). Driving under the influence of substances is associated with multiple risky driving behaviors such as speeding, riding with someone who has been drinking alcohol or using other drugs, and aggressive driving (Bingham & Shope, 2004; Patil et al., 2006). Additionally, research shows that drivers with multiple incidences of impaired driving often have a substance use disorder (LaPlante et al., 2008), and risky driving behaviors occur more frequently among individuals who experience substance use problems (Bingham & Shope, 2004).

Research examining correlations between substance misuse and impulsivity in the driving context can also provide insight. In a study of people diagnosed with alcohol dependence, Jakubczyk et al. (2013) found those who score higher on impulsiveness scales engage in more risky behaviors and have significantly more traffic crashes after drinking alcohol. Impulsivity was the most important predictor of risky behaviors in this study (Jakubczyk et al., 2013). Moreover, Curran et al. (2010) investigated the influence of impulsivity on drivers who engage in driving under the influence/driving while intoxicated (DUI/DWI) and found that those who have been convicted of DUI/DWI have higher levels of sensation seeking and impulsivity than those in the non-DUI/DWI group (p. 93). Considering the established research connection between impulsivity and problematic substance use and multiple risky driving behaviors, creating an intervention designed to improve multiple risky driver behaviors will need to include elements of substance use screening and referral to treatment.

#### 4.2.4.3 Psychological Reactance

Psychological reactance is “an unpleasant motivational arousal that emerges when people experience a threat to or loss of their free behaviors” (Steindl et al., 2015, p. 205). It has been suggested that when a person’s choices (freedoms) are threatened or lost, reactance is elicited, and the person may be motivated to respond in ways that reestablish those freedoms (Quick & Stephenson, 2007). In a study done by the Traffic Safety Culture Pooled Fund to better understand psychological reactance regarding two traffic safety behaviors (wearing a seat belt and driving aggressively), it was found that those who rarely or never used a seat belt exhibited more situational psychological reactance (a situational response to a perceived threat) but not trait reactance (a characteristic or trait that some are more prone to have than others); those who frequently drove aggressively exhibited more proneness and situational psychological reactance (Otto et al., 2021). While additional research is needed to understand the nuances of psychological reactance in the context of traffic safety, it may be a critical component of multiple risky driving behaviors and strategies to consider reducing psychological reactance in the development and design of an intervention.

Table 2 provides an overview of the factors that are associated with specific risky driving behaviors.

**Table 2. Factors Associated With Specific Risky Driving Behaviors**

Factors						Sources
	Speeding	Impaired Driving	Seat Belt Use	Distracted Driving	Other	
Impulsivity	X	X	X	X	X Aggressive Driving	Pearson et al., 2013; Paaver et al., 2006; Ryb et al., 2006
Sensation Seeking	X	X		X	X Unsafe Passing, Ignorance of Traffic Rules	Akbari et al., 2019; Pearson et al., 2013; Jonah, 1997; Iversen & Rundmo, 2002; Dahlen & White, 2006
Risk Perceptions	X	X	X	X	X Tailgating, Driving fast just for the thrill of it	Dionne et al., 2007; Ryb et al., 2006; Ivers et al., 2009; Bingham et al., 2007
Attitudes & Beliefs	X	X	X	X		Venkatraman et al., 2021; Schneider et al., 2017; Fylan et al., 2006; Kong et al., 2013; Bachoo et al., 2013; Li et al., 2021; Webb & Sheeran, 2006; Elliot & Armitage, 2009

Driving Anger	X				X Rule violations	Akbari et al., 2019; Iversen & Rundmo, 2002; Deffenbacher et al., 2016
Aggression	X				X Weaving through traffic, Using Shoulder to Pass, Rule Violations	Constantinou et al., 2011; Ulleberg & Rundmo, 2003
Big 5	X		X	X	X Aggressive Driving	Akbari et al., 2019
Reward Sensitivity	X	X				Scott-Parker & Weston, 2017
Tolerance of Deviance	X	X	X		X Aggressive Driving	Patil et al., 2006; Bingham & Shope, 2004
Demographics	X			X	X Aggressive Driving	Scott-Parker & Weston, 2017; Constantinou et al., 2011; Atombo et al., 2017
Substance Use	X	X			X Aggressive Driving	LaPlante et al., 2008; Bingham & Shope, 2004; Patil et al., 2006
Psychological Reactance		X	X			Richards et al., 2021; Otto et al., 2021

### 4.3 Strategies to Reduce Risky Driving Behaviors, Impulsivity, and Other Factors

To inform the development of a successful intervention to address multiple risky driving behaviors, strategies to reduce risky driving behaviors, impulsivity, and other factors associated with risky driving behaviors are included in this review.

#### 4.3.1 Speeding

While deterrence strategies (i.e., enforcement) and engineering strategies are common strategies to address speeding, other strategies that account for the “human, psychological, and emotional factors in speeding” are gaining momentum (Venkatraman et al., 2021, p. 189). Research suggests that strong predictors of speeding behavior are intentions, attitudes, perceived behavioral control, and self-efficacy (Fylan et al., 2006). It has been suggested that effective interventions to reduce speeding should target:

- “attitudes (beliefs and values) towards speeding;
- beliefs about the acceptability and ubiquity of speeding;
- the driver’s responsibility for their own speed choice;
- perceptions of the likelihood of being detected;

- perceptions of the benefits of speeding and the negative consequences of being caught or of crashing;
- perceived barriers to driving at an appropriate speed;
- the way in which speeding makes drivers feel;
- drivers' perceptions of their ability to drive at an appropriate speed; and
- when and where drivers will reduce their speed.” (Fylan et al., 2006, pp. 6-7)

Further, the perceived benefits of speeding may be as important as the perceived risks of speeding; thus, interventions might need to “undermine the perception that speeding is associated with benefits” and “promote the idea that there are costs, other than crashing, associated with speeding” (Fylan et al., 2006, p. 8). It has also been suggested that interventions should “promote the idea that drivers have control over the speed they adopt and that barriers to driving slowly are easy to overcome; undermine the effect of normative pressure on driving fast; and promote the affective benefits of driving more slowly” (Fylan et al., 2006, p.8). Understanding different types of speeders, their motivations to speed, and their attitudes about speeding is also important so that interventions can be tailored (Venkatraman et al., 2021; Fylan et al., 2006).

Behavioral intervention efforts to reduce speeding identified in *Countermeasures that Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices (2020)* sought to consider the factors associated with drivers who speed. One such effort was specific to targeting impulsiveness (see Section 4.3.5 for more information on this intervention). Another intervention included an intensive personal intervention that focused on attitudes, skills, and knowledge relating to crash risk among young adult males (Venkatraman et al., 2021). This intervention included six skill coaching sessions that focused on driver skills. The focus of the sessions included coaching on specific driving skills of interest to participants and addressed deficiencies that contribute to their risky behavior (Tapp et al., 2013). In addition to the coaching sessions, an in-vehicle recording device was used to give drivers feedback on their driving performance. The intervention was designed using social marketing as a platform to motivate and engage participants rather than traditional strategies such as fear appeals, punitive strategies, or stand-alone educational components (Tapp et al., 2013). While this study was small, research results showed improvement in driving skills among participants; however, it was suggested that further studies with a larger number of participants are needed (Tapp et al., 2013).

Another intervention to address speeding included elements of feedback and goal setting as reinforcers to reduce speed violations (Newnam et al., 2014). In this study, participants had data devices installed in their vehicles to monitor speeding behavior. Then, participants received weekly feedback on their speeding performance. Each week, participants were given information on the percentage of time they spent within the speed limit and exceeding the speed limit, how their behavior compared to other drivers in the intervention, and their safety rank compared to other drivers in the intervention. Participants also did goal setting exercises to encourage them to reduce their speeding violations for the next week (Newnam et al., 2014). Results showed this behavior modification intervention did reduce overall over-speed violations (Newnam et al., 2014).

### 4.3.2 Impaired Driving

Common strategies to reduce impaired driving include laws, enforcement, prosecution and adjudication, treatment and monitoring, and prevention (Venkatraman et al., 2021). Among the prevention strategies identified in *Countermeasures that Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*, screening coupled with brief intervention is considered an effective countermeasure to address alcohol-impaired driving (Venkatraman et al., 2021). Screening, brief intervention, and referral to treatment (SBIRT) is an approach that has been widely used in a variety of settings to reduce the negative consequences associated with substance misuse (Agerwala & McCance-Katz, 2012). SBIRT is considered an effective countermeasure to address alcohol-impaired driving (Venkatraman et al., 2021). The focus of SBIRT is to offer early intervention services and referral to treatment for individuals who are at risk of developing substance use disorders (SUDs) or who have already developed SUDs.

SBIRT has three primary components: screening, brief intervention, and referral to treatment. Screening includes an assessment of an individual's substance use. Brief screening tools such as the CAGE and Alcohol Use Disorders Identification Test (AUDIT: Saunders et al., 1993) are commonly used. If the person indicates problematic substance use or a pattern of use that may lead to problems, then a brief intervention is provided (Agerwala & McCance-Katz, 2012). Brief interventions vary in length from one interaction lasting only a few minutes to multiple sessions over time and are often based on motivational intervening strategies that seek to bolster an individual's motivation to lower their risk of developing a substance use disorder or change their substance use behavior (Agerwala & McCance-Katz, 2012). Referral to treatment is also an option for individuals who need more intensive services including counseling to address a substance use disorder.

In a meta-analysis examining the effectiveness of brief interventions to reduce driving after drinking, Steinka-Fry et al. (2015) found that compared to those who did not participate in brief alcohol interventions, those who did participate reported reduced drinking and driving and related consequences and suggested brief interventions may be a promising intervention to reduce impaired driving. Further, recognizing that substance misuse is associated with multiple risky driving behaviors, it will be important to provide an intervention that includes elements of screening and referral to treatment.

### 4.3.3 Seat Belt Use

Like other high-risk behaviors, common countermeasures to improve seat belt use include laws, enforcement, communications, and outreach (Venkatraman et al., 2021; Schneider et al., 2017). Brief interventions have also been used to increase seat belt use (Fernandez et al., 2008). For example, a study tested a brief motivational intervention to increase self-reported seat belt use among patients in an emergency department (Fernandez et al., 2008). In this study, the intervention was adapted from an alcohol/substance use brief intervention, took approximately 5 to 7 minutes to administer, and incorporated common elements of motivational interviewing including "1) establishing rapport with the client; 2) asking permission to discuss the high-risk behavior; 3) exploring pros and cons of engaging in high-risk behavior; 4) eliciting the gap

between actual and desired health outcomes; and 5) assessing readiness to change on a ruler scaled from 1 (not ready) to 10 (ready)” and creating an action plan for change based on the client’s goals (Fernandez et al., 2008, p. 421). The results of the study showed that those in the “intervention group had significantly higher improvements in mean seat belt use scores than the control group at 3-month follow-up” (Fernandez et al., 2008, p. 422). At six-month follow up, the differences were sustained; those in the intervention group had greater mean seat belt use scores than those in the control group (Fernandez et al., 2009).

Research shows driver motivations, habits, and routines are strongly correlated with seat belt use (Schneider et al. 2017). Studies have also found that unfavorable attitudes and beliefs toward seat belt use predict less frequent seat belt use (Watson & Austin, 2021). See section 4.3.7 for more information about modifying attitudes, normative beliefs, and control beliefs. While there are limited research studies that focus on specific seat belt interventions, research on factors associated with seat belt use have revealed some interesting findings that may be considered in designing an intervention. One study revealed that instead of viewing seat belt use as a binary where either one does or does not use a seat belt, seat belt use behavior should be viewed on a continuum that is influenced by various situations and circumstances (Schneider et al., 2017). For example, some people are highly motivated to wear a seat belt but have not yet developed a habit of doing so and don’t have a stable routine to support the behavior, while others are not motivated to wear a seat belt and have beliefs supportive of not engaging in the behavior (Schneider et al., 2017). Thus, interventions seeking to increase seat belt use will require a variety of strategies tailored to the specific audience.

#### 4.3.4 Distracted Driving

Law enforcement strategies and environmental and vehicular strategies (i.e., rumble stripes, visible road signs, vehicle warning technology) are common to address distracted driving (Venkatraman et al., 2021). Among the behavioral strategies identified in *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*, employee distracted driving programs were listed as a countermeasure, but their effectiveness has not been determined because there is a lack of evidence (Venkatraman et al., 2021). One such employee-based intervention is *Just Drive – Take Action Against Distraction*. This work-based intervention was designed to increase awareness of the dangers of distracted driving, decrease distracted driving, and encourage safe driving behaviors among employees. In a study to understand the impact of the Just Drive intervention, Hill et al. (2020) found that participants had a significant increase in knowledge about distracted driving risks and intended to change their distracted driving behaviors. At a three month follow up, participants reported changes in their distracted driving behaviors (Hill et al., 2020).

Other interventions to influence distracted driving behavior have been attempted with varying success. In a five-week, peer-led educational intervention that included video, group discussion, and a presentation about distracted driving (i.e., what distracted driving is, why young drivers are at high risk of distracted driving, ways to avoid distraction, distracted driving laws), it was found that those in the intervention group, compared to the control group, had increased knowledge about distracted driving and decreased distracted driving behaviors including cell phone use and

sending text messages while driving (Berlin et al., 2021). Another intervention for distracted driving used an evidence-based interactive distracted driving website to engage parents in having conversations with their teens about distracted driving (Ehrlich et al., 2020). The intervention, Drive Smart, included three components in the intervention. First, there was a parent/teen toolkit that included a parent/teen driving agreement, informational brochure, and a cell keeper bag (Ehrlich et al., 2020). Second, there was an interactive educational program that included distracted driving scenarios and safe driving tips. And third, there was a list of phone apps teens could download to prevent a cell phone from working while the vehicle is in motion (Ehrlich et al., 2020). Results from a study of the Drive Smart intervention suggested that parents rarely talk with their children about distracted driving and that the tools such as the parent/teen agreement in the Drive Smart intervention was a good starting place to initiate those important conversations (Ehrlich et al., 2020).

A study conducted by Fournier et al. (2016) tested an intervention to decrease cell phone use while driving on a university campus. The intervention involved fear-based appeals, pledges, and behavioral prompts. The campaign consisted of thumb bands that read, “It can W8,” a pledge sheet for students to sign, and flyers. The fear-based appeal was delivered in the form of flyers that depicted the image of a little girl on a roadway with a message that said, “You tell my mom you only looked away for a second.” This was followed by a call to action to “Wear your thumb band to remind yourself and others that IT CAN W8.” Following the intervention, the researchers noted a significant decrease in drivers talking on a cell phone. However, the researchers observed an increase in drivers texting.

#### 4.3.5 Impulsivity

Given the research that impulsivity is a factor associated with multiple risky driving behaviors, a review of literature was conducted to understand how to influence impulsive behaviors. It has been suggested that interventions to address impulsivity should seek to increase the ability to delay gratification or inhibit behaviors (Chamorro et al., 2012). However, literature on interventions that target impulsivity is sparse. Only one intervention designed to target impulsiveness in drivers was found, but the results of this intervention appeared promising to reduce multiple risky driving behaviors among novice drivers (Paaver et al., 2013; Eensoo et al., 2018).

The brief intervention designed to reduce impulsiveness in novice drivers was conducted as part of a driving school where students were divided into two groups (Paaver et al., 2013). One group received the intervention, and one group was considered the control group and did not receive the intervention. A total of 1,866 students participated in the study.

The brief intervention included education on impulsivity (i.e., different types of impulsivity, how impulsivity is related to risk-taking, how to recognize impulsiveness in oneself, and situational factors that could potentially trigger impulsive behavior) and group work that focused on identifying psychological factors involved in traffic crashes, assessing one’s own risk, and focusing on ways to decrease risk including teaching skills such as self-monitoring and self-regulation (Paaver et al., 2013).

In the year following the intervention period, students were monitored for a variety of traffic behaviors including at fault (active) crashes, not at fault (passive) crashes, speeding, drunk driving, and general traffic risk (crashes and penalties for any violations) (Paaver et al., 2013). When comparing those in the intervention group to those in the control group, those in the control group were cited for more speeding violations than those in the intervention group. Those who participated in the intervention had decreased odds of being cited for speeding by half (Paaver et al., 2013). The intervention did not have a significant effect on the other traffic offenses. However, when the intervention group was compared to all subjects (those in the control group and those that were assigned to the intervention group but did not complete the intervention), the intervention group had fewer speeding violations, fewer passive crashes, and fewer drunk driving incidents (Paaver et al., 2013).

A follow-up study after the initial intervention tracked traffic violations and traffic crashes for a period of four years. Results revealed that the benefits of participating in the intervention remained; “speeding, drunk driving, and involvement in traffic accidents were significantly lower in the intervention group” (Eensoo et al., 2018, p. 19).

While interventions to reduce impulsivity in traffic safety are limited, understanding other strategies that have been used to reduce impulsivity in general may be insightful. Emotion regulation training has been cited as a potentially effective way to reduce impulsivity (Malekimajd et al., 2016; Aazam et al., 2014; Asgari & Matini, 2020).

Emotion regulation is defined as changing one’s response to emotions to better their wellbeing (Gross, 2002). Emotion regulation training can reduce impulsivity (Malekimajd et al., 2016; Aazam et al., 2014; Asgari & Matini, 2020). For example, in a study of juvenile offenders, Malekimajd and colleagues (2016) found that emotion regulation training reduced impulsivity, increased positive affect, and decreased negative affect. Two other studies (Aazam et al., 2014; Asgari & Matini, 2020) found that emotion regulation training reduced impulsivity in both individuals who smoked and individuals with a substance use disorder. Emotion regulation training has also been used as a strategy to reduce anger (Massah et al., 2016).

Gross’s (2002) process model of emotion regulation is a commonly utilized model to reduce and control negative emotions and amplify positive emotions associated with various high-risk behaviors. Gross’s process model of emotion regulation identifies a process for how to regulate or change a person’s emotions. The process includes five strategies to regulate emotions: situation selection (making choices that will influence how one feels), situation modification (tailoring a situation to change how it will affect one’s feelings), deployment of attention (deciding what to focus on or give attention to), change of cognitions (attaching meaning to the situation that will influence how one feels), and modulation of experiential, behavioral or physiological response (changing how one feels after feelings have already been experienced) (Gross, 2002).

A traffic safety example can be used to illustrate Gross’s process model of emotion regulation. Consider a person who tends to get angry while driving, especially when there is traffic congestion. Recognizing that the person gets angry while driving when there are more people on

the road, the person chooses to change their commute to work to avoid the bulk of traffic (situation selection). Choosing to commute at a time that is less busy, the person recognizes the carpool lane is moving more smoothly and chooses to use that lane to avoid getting angry (situation modification), realizes that this is saving time (deployment of attention), and begins to think about their commute in a more positive way (change of cognition). When getting cut off in traffic by another driver, the person experiences anger but instead of reacting negatively by tailgating or speeding up, they modify their response to their anger by taking some deep breaths and continue to drive in a safe manner (modulation of response). The process of emotion regulation training is to identify emotions accurately, teach skills to regulate emotions (problem-solving, attention modification, conflict resolution, emotion expression, mindfulness-based practices, etc.), and then learn to employ those skills/strategies that change the impact of emotions on a person's behavior.

#### 4.3.6 Risk Perceptions

Literature suggests that “when interventions successfully change risk perceptions, health behavior change often results” (Ferrer & Klein, 2015, p.85). However, a meta-analysis conducted by Sheeran et al. in 2014 found that while heightening risk perceptions did change health behaviors, the effects were small. This research also clarified that multiple components of risk perception must be heightened. These elements include anticipatory emotion, anticipated emotion, and perceived severity (Sheeran et al., 2014). To have a greater effect on health behaviors, interventions that heighten risk perceptions through messaging need to make the individual “(a) believe there is a risk, (b) feel worried about the threat, (c) feel guilty if they do not act, and (d) believe that the harm would be severe” (Sheeran et al., 2014, p. 534). This meta-analysis also found that the most successful risk appraisal interventions addressed multiple elements of risk appraisals and increased coping appraisals. Coping appraisals were defined as “people’s belief about the efficacy of the recommended action, their confidence about undertaking that action, and their beliefs about the costs of doing so” (p. 534). Another study (Butters et al., 2012) suggested that changing risk perceptions to address risky driving behavior should be tailored by gender. The study found that females were more concerned with driver safety issues and more supportive of impaired driving countermeasures than males. The authors suggest that “initiatives to build support for such policies or for changing concern for risky driving behaviors need to be conceptualized and designed separately for males and females” (Butters et al., 2012, p.410).

#### 4.3.7 Modifying Mediating Factors

Interventions to change problem behaviors may be more successful when they are designed to focus on modifying the mediating factors that link personality and psychological factors to the target behaviors (Patil et al., 2006). Attitudes are often found to be mediators (Ulleberg & Rundmo, 2003; Kong et al., 2013; Li et al., 2021). Driver attitudes are related to high-risk behaviors such as speeding (Venkatraman et al., 2021; Fylan et al., 2006; Rowe et al., 2016). Attitudes are also a strong predictor of intention to engage in driving violations including behaviors such as impaired driving and distracted driving (Rowe et al., 2016). Interventions that

target drivers' attitudes toward traffic safety to reduce risky driving behavior have been recommended (Kong et al., 2013; Bachoo et al., 2013; Li et al., 2021).

For example, in one study, attitudes were found to be a strong predictor of intention to engage in driving violations including behaviors such as speeding, impaired driving, and distracted driving (Rowe et al., 2016). In this study, behavioral beliefs predicted attitudes toward these driving violations, and it was suggested that interventions seeking to modify behavioral beliefs may be an important focus to reduce risky driving behaviors (Rowe et al., 2016). In a study of truck drivers, attitudes toward risky driving positively influenced intention to drive in a risky way (Li et al., 2021). It was found that attitudes towards risky driving significantly mediated both the relationship between sensation seeking and intention to drive riskily and risk perception and intention to drive riskily (Li et al., 2021). It was recommended that strategies to cultivate negative attitudes toward risky driving may be beneficial such as promoting activities like safety promotions, safety rewards, and safety gatherings (Li et al., 2021).

In the United Kingdom, a national speed awareness course is offered as an alternative to punishment for low-level speeding offenses. One of the main elements of reducing non-compliance with speed limits is to improve driver attitudes (Ipsos et al., 2018). The content for the course is based on a behavioral model and the work of Fylan et al. (2006) regarding predictors of speeding that suggested that speeding behavior is influenced by intentions, attitude, perceived behavioral control, and self-efficacy (Ipsos et al., 2018). In a study of this national speed awareness course, it was found that over a three-year period, the course was more effective at reducing speed reoffending than issuing a fine or penalty points (Ipsos et al., 2018).

Seeking to understand and change normative beliefs and control beliefs may also be targets of intervention. Studies have shown that changes to behavioral, normative, and control beliefs led to changes in intention to engage in a behavior (Elliot et al., 2005; Ward et al., 2017; Elliot & Armitage, 2009). One study showed that reported driving under the influence of cannabis behavior was predicted by willingness and intention to engage in that behavior (Scott et al., 2021). A meta-analysis of 47 experimental tests of intention-behavior relations conducted by Webb and Sheeran (2006) indicated that a medium to large change in intention led to a small to medium change in behavior (Webb & Sheeran, 2006). Normative beliefs are often a target of intervention for behaviors like drinking alcohol, distracted driving, speeding, and other risky driving behaviors (Parker et al., 1996; Parker, 2002). Zhou et al. (2009) found that the young drivers surveyed believed that significant other people would support their use of hands-free mobiles (normative belief), which correlated to an increase in intention to use hands-free mobile phones when driving. Simons-Morton et al. (2012) found that having friends who engage in risky behaviors reduced young drivers' perceptions about the risk of speeding and concluded that interventions to address perceived risk and perceived norms regarding speeding are needed.

Some interventions have sought to change both control and normative beliefs. A random controlled intervention based on the theory of planned behavior (TPB) was conducted in the United Kingdom to promote reductions in speeding (Elliott & Armitage, 2009). This study had 300 participants with 159 in the control group and 141 in the experimental group. All 300 participants responded to a baseline survey containing items to measure speeding behavior and

TPB variables. Following the baseline survey, the experimental group received an eight-page booklet containing information about the risks of speeding and persuasive messages to target specific behavioral, normative, and control beliefs associated with speeding. One month after the intervention (booklet), both groups were given the baseline survey again. The experiment showed no effect on behavioral and normative beliefs, but there was a significant effect on one control belief and measured speeding behavior (Elliot & Armitage, 2009). Most studies on TPB test the predictive validity of the model; this study goes a step further and provides evidence that “drivers’ perceptions of control accurately reflect their actual control” (Elliot & Armitage, 2009, p. 126).

Research regarding interventions that reduce risky driving behaviors such as speeding, impaired driving, seat belt use, and distracted driving have commonly relied on deterrence strategies (i.e., enforcement) and engineering strategies; however, there is increasing research to suggest that behavioral strategies are increasingly being included as countermeasures to reduce risky driving behaviors (Venkatraman et al., 2021). Behavioral strategies have included elements such as personalized feedback (Newnam et al., 2014); coaching (Tapp et al., 2013); heightening risk perceptions including anticipatory emotion, anticipated emotion, and perceived severity (Sheeran et al., 2014); and focusing on factors such as impulsivity (Paaver et al., 2013). Further, behavioral strategies have focused on attitudes, perceived behavioral control, normative beliefs, and self-efficacy in addition to teaching skills and knowledge relating to risky driving (Elliot et al., 2005; Ward et al., 2017; Elliot & Armitage, 2009; Li et al., 2021). These elements are important considerations for designing an intervention to address multiple risky driving behaviors.

#### **4.4 Intervention Delivery Methods**

As this project includes both designing and implementing an intervention to reduce multiple risky driving behaviors, various delivery methods are explored including mobile health technologies, brief interventions, and vehicle safety monitoring systems.

##### **4.4.1 Mobile Health Technologies**

Web-based instruction (WBI) opportunities have increased in popularity over the last decade because they do not require in-person instruction and yet they can deliver standardized educational opportunities (Camden et al., 2019).

Learning Management Systems (LMS) are web-based software systems that can be programmed to deliver educational content on any device, any time, and from anywhere. They are a popular learning platform for providing educational content in business and academic settings. Some open source LMS systems include [Moodle](#), [360Learning](#), and [ILIAS](#). Research evidence suggests that web-based learning is as effective as traditional learning instruction (Nguyen, 2015; Sitzmann et al., 2006). Camden et al. (2019) evaluated the effectiveness of an automatic targeted WBI program to reduce risky driving behaviors (i.e., rapid acceleration, hard braking, hard cornering, and speeding) and found that the WBI intervention significantly reduced the rate of risky driving behaviors.

McDonald et al. (2018) developed a web-based intervention to reduce adolescent driver inattention. Using e-learning software to develop the intervention and a Learning Management System (LMS) to deliver the intervention, McDonald and colleagues (2018) were able to create an intervention that participants could complete online without the help of a facilitator. With beta testing and pilot testing, McDonald et al. (2018) conducted a randomized controlled trial to establish feasibility of the web-based intervention. While the initial testing of the web-based intervention to reduce adolescent driver inattention did not find significant effects, the results did indicate the potential for reducing unsafe driving behaviors and it is possible that the small sample size of the study limited the researchers' ability to detect significant differences between groups (McDonald et al., 2021).

Another mobile health technology that has been studied to reduce risky behavior is the use of text messages and mobile phone apps to deliver brief interventions (Ameratunga et al., 2017; Badawy & Kuhns, 2017). Ameratunga et al. (2017) developed a brief text message intervention incorporating brief intervention principles into 16 informational and motivational text messages delivered over four weeks to reduce harmful drinking behavior among adults who had been discharged from an in-patient care setting. In a systematic review of texting and mobile phone app interventions to improve adherence to preventive behaviors in young people, Badawy and Kuhns (2017) found that about half of the studies that were included in the review demonstrated significant improvement in preventive behaviors. Delivering an intervention via text messages or mobile apps may be a strategy that can reach a wide range of people in a convenient and cost-effective way.

Mobile health technology may also be a delivery method that could augment existing programs and infrastructures that are already established, such as driver's education programs and programs for those who have been cited for driving under the influence of substances.

#### 4.4.2 Brief Interventions

Brief interventions include providing information about a behavior, understanding the person's perspective on the behavior, and offering feedback for the person to consider regarding ideas to change the specific behavior (Ameratunga et al., 2017, p. 2). Many brief interventions utilize elements of motivational interviewing to resolve ambivalence about changing behavior and to elicit desired behavior changes (Elwyn et al., 2014). The components of motivational interviewing include (1) Engaging, which focuses on building a relationship with the other person to explore their beliefs and feelings, (2) Focusing, which includes deciding on a direction for change, (3) Evoking, which focuses on eliciting the person's motivation for change, and (4) Planning, which includes developing a commitment to change and creating a plan of action (Elwyn et al., 2014).

Brief interventions that use motivational interviewing have been used to address a wide range of behaviors including smoking cessation, weight management behavior, sexual health behavior, adherence to medication, and driver behaviors like seat belt use, speeding, and impaired driving (Frost et al., 2018; Fylan et al., 2006; Steinka-Fry et al., 2015; Fernandez et al., 2008). Further, motivational interviewing has been used as a behavioral intervention for people with multiple health problems and multiple risk factors (Frost et al., 2018). Given the results of brief

interventions to improve driver behaviors, brief interventions may be appropriate to address multiple risky driving behaviors.

#### 4.4.3 Vehicle Safety Monitoring Systems

In-vehicle monitoring systems (IVMS), also called on-board safety monitoring systems (OBSM), are considered technologies that can monitor driving behavior and provide real-time or retrospective feedback about risky driving behaviors. Feedback about driving behavior is the primary mechanism for behavior change. The underlying assumptions are that providing drivers with feedback about their risky driving behavior will allow them to correct or change their risky driving behavior and providing feedback about their positive and safe driving behaviors will encourage more of those safe behaviors to continue (Horrey et al., 2012). Feedback to drivers can come in the form of “in-cab warning lights, sounds, reports, or by viewing video contents, all of which are intended to help drivers avoid or correct risky driving behaviors” (Bell et al., 2017, p. 125).

Research suggests that vehicle safety monitoring systems may be an effective strategy to reduce risky driving behaviors and encourage safe driving behaviors especially when combined with coaching (Bell et al., 2017; Hickman & Hanowski, 2011). In a study of commercial drivers, drivers who were provided with instant feedback from IVMS regarding harsh vehicle maneuvers like speeding, hard braking, and swerving, along with coaching from supervisors about safe driving practices had significantly fewer risky driving behaviors than those who received feedback from the IVMS alone or those in the control group (Bell et al., 2017). Similarly, another study found that combining in-vehicle safety monitoring systems and behavioral coaching reduced the rate of safety-related events (Hickman & Hanowski, 2011). Combining vehicle safety monitoring technology and coaching from parents or other respected adults may also be an effective strategy to improve driving behavior for young novice drivers, a particularly high-risk group engaging in multiple risky driving behaviors (Farah et al., 2014; Simons-Morton et al., 2013; McGehee et al., 2007).

It is evident that various methods have been used to successfully deliver interventions to reduce risky driving behaviors. In-person experiences, web-based mobile health technologies, brief interventions, and systems that monitor driving behavior and provide synchronous and asynchronous feedback using technology have been explored. To successfully reduce multiple risky driving behaviors, an intervention may need to be more intensive than if the intervention sought to address any single risky driving behavior in isolation. The intervention may need to consider combining various delivery methods to be most effective.

## 5 INTERVENTION DEVELOPMENT PLAN OUTLINE

### 5.1 Goal of Intervention

The brief intervention will be designed for drivers engaged in multiple risky driving behaviors.

The goal of the brief intervention is to reduce multiple risky driving behaviors and to avoid harmful consequences as a result. Toward this end, the proposed intervention seeks to

- meet the person where they are in the process of behavior change,
- explore cognitions related to multiple risky driving behaviors,
- provide behavioral strategies to increase safe driving behaviors, and
- use strategies that seek to grow a person's motivation.

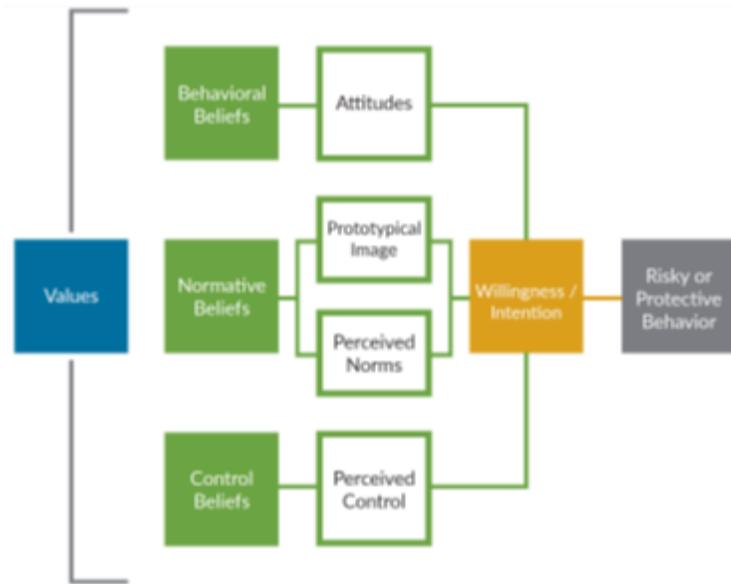
### 5.2 Intervention Development and Content

#### 5.2.1 Theoretical Foundation

The intervention designed for drivers engaged in multiple risky driving behaviors will have a strong theoretical foundation. An Integrated Behavior Model, Motivational Interviewing, Transtheoretical Model of Behavioral Change, Harm Reduction, Cognitive-Behavioral Approach, and a Strengths-Based Perspective are briefly described and will be used in the design of the intervention to reduce multiple risky driving behaviors. Further, the intervention will also focus on impulsivity and risk perceptions as these factors are associated with multiple risky driving behaviors (Barati et al., 2020; Dionne et al., 2007; Ryb et al., 2006).

#### 5.2.1.1 Integrated Behavior Model

The integrated behavior model will be used to inform the assessments created for this project and the development of the intervention curriculum regarding behavioral beliefs, normative beliefs, and control beliefs and their relative impact on the multiple risky driving behaviors we are seeking to change. The integrated behavior model brings together several components from models shown to be effective from research (Fishbein & Ajzen, 2009; Gerrard et al., 2008) (See Figure 1). The integrated behavior model defines several “constructs” that can be measured for an individual. The relative impact of each construct on behavior can be assessed using statistical analytical techniques (such as regression analyses). By understanding which constructs influence decision making, interventions can be developed to grow these beliefs and thereby influence behavior. Table 3 summarizes each construct.



**Figure 1. Integrated Behavior Model**

**Table 3. Definitions of Constructs Used in Integrated Behavior Model**

Attitudes	Subjective evaluation of an object or behavior in terms of emotional reaction (e.g., “Speeding is exciting”) and perceived utility (e.g., “I can socialize better when I drink”).
Behavioral Beliefs	Expectations about the physical and social consequences of a behavior (e.g., “If I speed, I will likely get an expensive fine,” “If I drink and drive, my friends will exclude me”).
Construct	Constructs are the concepts developed or adopted for use in a particular theory. An example of a construct is “attitude” or “perceived control.”
Control Beliefs	Beliefs about my ability to engage or not engage in the behavior based on factors that are either internal or external to oneself (e.g., “Crashes are determined by fate,” “It does not matter what I say because my child does not listen to me”).
Intention	The deliberate decision to commit a behavior in an anticipated situation (e.g., “I intend to wear my seat belt every time I am in a vehicle”).
Normative Beliefs	Beliefs about (1) what behaviors are most common in a group (e.g., “All my friends speed”); (2) what important people in that group expect (e.g., “My parents expect me not to drink”); and (3) what are the shared characteristics of people perceived to typically engage (or abstain) in that behavior.
Perceived Control	Perception of our ability to determine our own behaviors (e.g., “I can choose my own speed in traffic”).
Perceived Norms	The behavior believed to be common and expected in a given context (e.g., wearing a seat belt when driving with parents).

Prototypical Image	The stereotype of people perceived to typically engage in the behavior (e.g., “People who speed are cool”).
Values	Ideals to which we aspire that define the goals for our behavioral choices and direct the formation of our belief systems (e.g., “I must protect my family,” “I desire a life without stress”).
Willingness	The predisposition to commit a behavior if an unexpected situation arises (e.g., “I am more willing to speed if everyone else around me is speeding”).

**5.2.1.2 Motivational Interviewing**

Motivational Interviewing was developed as a change process that seeks to engage a person in their stage of readiness and help the person explore ambivalence about changing their risky behaviors (Miller & Rollnick, 2002). Motivational interviewing uses Prochaska and DiClemente’s stages of change model to assess a person’s readiness for change and then seeks to match their intervention to the person’s motivation (Dimeff et al., 1999).

The intervention created to reduce multiple risky driving behaviors will use Miller and Rollnick’s (2002) motivational interviewing approach and specifically their “FRAMES” to structure the content development process for the brief intervention. The FRAMES has been used in other interventions to reduce risky behaviors (Dimeff et al., 1999) and is adapted here to include:

- **Feedback** – information about multiple risky driving behaviors, risks, normative behavior
- **Responsibility** – emphasis placed on the person's responsibility for change
- **Advice** – simple advice on what to change
- **Menu** (of options) – provision of a range of options to select from
- **Empathy** – ability to see the situation from the person’s perspective, while also maintaining a perspective outside their reality
- **Self-efficacy** – the person’s belief in his or her ability to make successful changes

**5.2.1.3 Transtheoretical Model of Behavioral Change**

Prochaska and Di Clemente’s Transtheoretical Model of Behavioral Change (TTM) suggests that change occurs over time through stages, not all at once (DiClemente, 2018). Thus, efforts to change behavior may be more successful if the effort seeks to meet the person where they are and recognizes that change is not a linear process but one that includes progress and regression (DiClemente, 2018). TTM can be used to create new behaviors, modify existing behaviors, and stop detrimental behaviors (DiClemente, 2018). TTM has been used to assess the stages of change in high-risk driving behaviors (Khadem-Rezaiyan et al., 2017). In the stages of change model, five stages are identified (DiClemente, 2018):

1. Precontemplation – when “a person is unaware (or under aware) of risks or problems associated with a particular behavior” (Dimeff et al., 1999, p. 34), the person is not considering a change, or not intending to take action to change soon (DiClemente, 2018).
2. Contemplation – when “a person begins to recognize that some hazards and/or problems exist and gives thought to making a change in his or her behavior but has not yet made a firm commitment to change” (Dimeff et al., 1999, p. 34), a person conducts a cost/benefit analysis regarding their current behavior (DiClemente, 2018).
3. Preparation – when a person takes steps or prepares for change (DiClemente, 2018). “Preparation combines intention with behavior and usually follows once ambivalence is resolved or diminished” (Dimeff et al., 1999, p. 35).
4. Action – when a person has taken specific actions to make a change and “modifies his or her behavior and/or environment in order to overcome the problem” (Dimeff et al., 1999, p. 35).
5. Maintenance – when a person takes actions to “support and maintain the behavioral gains that have been made” (Dimeff et al., 1999, p. 35), and the behavior is integrated into the individual’s lifestyle (DiClemente, 2018).

It has been suggested that intervention strategies that don’t align with an individual’s readiness can result in psychological reactance and render change unlikely (Dimeff et al., 1999; Brehm & Brehm, 1981). The intervention created to reduce multiple risky driving behaviors will assess readiness for change so that strategies can be matched to the individual’s readiness for change.

#### **5.2.1.4 Harm Reduction**

A harm reduction approach acknowledges that change occurs over time, not all at once (Dimeff et al., 1999). It is a “strategy directed at an individual or groups that aims to reduce the harms associated with certain behaviors” (Canadian Paediatric Society, 2008, p. 53). A harm reduction approach may be considered in the development of the intervention for this project. The goal of harm reduction is to increase knowledge and target the reduction of associated harms rather than frequency or amount of engagement in a risky behavior (Jenkins et al., 2017). This approach moves beyond abstinence only and provides individuals with strategies to minimize harm while engaging in risky behaviors (Senserrick et al., 2021). Harm reduction keeps the focus of attention on the damage done by the behavior and not the behavior itself (Brown & Stewart, 2021). Focusing on harm reduction allows room to meet individuals where they are and engage in a collaborative process often through motivational interviewing to identify problems and create solutions. Harm reduction acknowledges the autonomy of the individual and treats individuals with respect (Richards et al., 2021). The choice to reduce engagement in a behavior and then select what strategies to employ come from the individual. A recent article in the *Journal of Transport and Health* (Senserrick et al., 2021) presented arguments for incorporation of harm reduction in young driver education. They claim that harm reduction has been successful in youth education of other risky behaviors such as alcohol and drug use and applying some similar concepts to youth driver education may have benefits. While still emphasizing the importance of “abstinence is best” regarding engagement in risky driving behaviors, their arguments highlight

some critical issues of inequities, role of peers and parents, need to teach risk compensating behaviors, and the lack of acknowledgement of youth drivers' lived experiences as reasons to explore a harm reduction approach in traffic safety especially for youth (Senserrick et al., 2021).

#### **5.2.1.5 Cognitive-Behavioral Approach**

A cognitive-behavioral approach seeks to help a person identify their thoughts, understand how their thoughts influence behaviors, and provide strategies to manage/change behaviors to reduce high-risk behaviors (Dimeff et al., 1999). In an intervention to address multiple risky driving behaviors, a cognitive-behavioral approach will be used to teach an individual engaging in multiple risky behaviors how to identify thoughts, emotions, and beliefs that are influencing their multiple risky driving behaviors, reshape those cognitions to support safer driving behaviors, and understand the individual strategies they could use to engage in safer driving behaviors.

#### **5.2.1.6 A Strengths-Based Perspective**

A strengths-based perspective suggests that building on one's strengths, skills, and capacities can foster change and "can be used for movement toward their aspirations..." (Saleebey, 2001, p. 78). Through intentional questions that focus on what possibilities exist, effort to change behavior may be more effective when we seek to nurture a person's strengths and to draw on those strengths when engaging in change. Thus, the intervention proposed for this project will use the guiding belief that individuals engaging in multiple risky driving behaviors have unique strengths and capabilities they can draw on to aid them in making changes toward healthier and safer driving decisions and behaviors.

### **5.2.2 Intervention Description**

We are proposing an intervention that includes web-based virtual modules and a series of text messages to support participant learning between each module completion. We will seek to develop an intervention that can be delivered by individuals in a wide range of professional roles (e.g., DUI class leaders, driver's education instructors) and can stand alone or be augmented to accompany an existing program or strategy.

The intervention will target specific factors associated with multiple risky driving behaviors including impulsivity, risk perceptions, and attitudes and beliefs associated with risky driving behaviors. Table 4 shows the logic model created for the proposed intervention.

**Table 4. Logic Model Created for the Proposed Intervention**

<b>Multiple Risky Driving Behaviors</b>					
<b>Strategy: Brief Intervention</b>					
<b>Problem Identification / Opportunity</b>	<b>Strategy Goals</b> Broad action statements about the purpose(s) of the strategy and what it is intended to accomplish	<b>Short-Term Outcomes</b> (e.g. skills, knowledge, beliefs)	<b>Intermediate Outcomes</b> (e.g. behaviors)	<b>Long-Term Outcomes</b> (e.g. consequences)	<b>Health Impacts</b>
<p>Multiple risky driving behaviors result in negative consequences including increased crash risk, serious injuries, and fatalities.</p> <p>There is a gap in understanding how to address impulsivity and the underlying beliefs and behaviors of individuals engaging in multiple risky driving behaviors.</p> <p>Drivers engaging in multiple risky behaviors – (such as not using a seat belt, speeding, and driving impaired) – may require more intensive or</p>	<p>Reduce multiple risky driving behaviors to improve safety through a brief intervention that targets specific factors including:</p> <ul style="list-style-type: none"> <li>Impulsivity</li> <li>Risk</li> <li>Perceptions</li> <li>Attitudes and Beliefs</li> </ul> <p>Provide education on multiple risky driving behaviors.</p> <p>Build motivation and commitment for change.</p>	<p>Understand why multiple risky driving behaviors are particularly problematic</p> <p>Increase understanding of cognitions and feelings related to risk driving behaviors</p> <p>Increase commitment to implement a strategy to reduce multiple risky driving behavior</p> <p><b>Use strategies from intervention (skills to</b></p>	<p>Decrease engagement in risky driving behaviors (one or more):</p> <p><b>Speeding<sup>o</sup></b></p> <p><b>Distracted<sup>o</sup></b></p> <p><b>Impaired driving<sup>o</sup></b></p> <p><b>Seat belt use<sup>o</sup></b></p> <p>Based on targeted skills, knowledge, and beliefs, participants may:</p> <p><b>Increase risk compensating behaviors<sup>o</sup></b></p> <p><b>Decrease impulsivity<sup>o</sup></b></p>	<p>Decrease serious injuries and fatalities on roadways</p> <p>Decrease in citations</p>	<p>Fewer poor driving outcomes</p> <p>Improved mental, emotional, and behavioral (MEB) health. MEB is important for individuals to thrive (National Academies of Sciences, Engineering, and Medicine, 2019).</p>

<p>different interventions than are typically provided to drivers who are cited for any one of these risky behaviors in isolation.</p> <p>There is an opportunity to use a harm reduction approach to traffic safety.</p>	<p>Provide personalized feedback about multiple risky driving beliefs and behaviors.</p> <p>Provide specific advice for strategies based on feedback to reduce multiple risky driving and improve safety.</p>	<p><b>reduce high risk driving) <sup>p</sup></b></p> <p><b>Increase knowledge of compensating behaviors <sup>p</sup></b></p> <p><b>Increased risk perceptions <sup>o</sup></b></p> <p>Increase emotional regulation</p> <p>Increase self-efficacy</p> <p><b>Increase protective beliefs (control, normative) <sup>o</sup></b></p>			
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Notes: Bold items will be measured. <sup>p</sup>Process measures; <sup>o</sup>Outcome measures

Participants who are randomized to the intervention will begin and complete the intervention on a rolling basis after consent. An overview of the modules and supportive text messages are outlined:

**1. Module 1 – Overview of Intervention, Education, and Personalized Feedback**

- a. Time Required: 40 minutes
- b. After consent and randomization, participants in the intervention group will have one week to complete Module 1 followed by two weeks to practice selected strategy
- c. Module 1 Objectives:
  - i. Explain purpose and structure of intervention and personalized feedback
  - ii. Provide education about high-risk driving behaviors and risks
  - iii. Get commitment from participant to participate in the intervention including receiving text messages as well as a commitment to not engage with materials or text messages while operating a motor vehicle
  - iv. Provide personalized feedback based on baseline assessment
  - v. Give specific advice about ways to reduce risky driving behaviors (Behavioral Strategies)

1. Based on personalized feedback, participant selects strategy option(s)
    2. Build motivation and commitment to change
    3. Ask for commitment
  - d. Text Message Objectives:
    - i. Support strategies
    - ii. Support behavior change
    - iii. Build motivation and commitment to change
    - iv. Provide avenue for additional support
- 2. Module 2 – Strengthening Commitment to Change**
  - a. Time Required: 10 minutes
  - b. One week to completed Module 2 followed by one week to practice selected strategy
  - c. Module 2 Objectives:
    - i. Review selected strategy
    - ii. Check in on selected strategy
      1. Celebrate successes (what worked)
      2. Affirm progress and enhance motivation
      3. Explore what can be changed to increase success
  - d. Text Message Objectives:
    - i. Support strategies
    - ii. Support behavior change
    - iii. Build motivation and commitment to change
    - iv. Provide avenue for additional support

### 5.2.3 Intervention Pilot Testing

To optimize outcomes and make best use of limited resources, the intervention will be pilot tested and refined before seeking wider implementation in a randomized controlled trial. We will pilot test the experience of the intervention group (baseline assessment, intervention, and post-assessment). We will use a Qualtrics purchased panel to complete the pilot testing.

## 6 EVALUATION AND IMPLEMENTATION PLAN OUTLINE

### 6.1 Study Aim

The aim of the current study is to test the efficacy of a brief intervention designed to reduce multiple risky driving behaviors. The outcomes of interest are speeding, driving under the influence, seat belt use, and distracted driving.

### 6.2 Study Setting and Participants

Participants in this study will be recruited from a university through email advertising and social media posting about the study. Individuals who respond to the study advertisements will be given introductory information about the study and will be screened for eligibility. Eligibility criteria:

- Age 18 or older
- Hold a valid driver's license
- Report driving at least once a week
- Report engaging in at least two risky driving behaviors in the past month

### 6.3 Method and Design

All procedures will be approved by the Montana State University Institutional Review Board for human subjects research before the study begins, and participants will provide informed consent.

We will use a randomized controlled trial design to test if the brief intervention decreases multiple risky driving behaviors. Eligible participants will be randomly assigned to one condition – control or intervention. All participants will complete measures at three timepoints – baseline, post-intervention (i.e., immediately following intervention for intervention participants and the same time delay from baseline for control participants), and follow up (i.e., three months following post-intervention).

All data will be gathered via self-report, and measures will assess outcomes as well as the beliefs and factors targeted by the intervention. Demographic information will be collected at baseline.

Outcome measures:

- A. Speeding
- B. Driving under the influence
- C. Seat belt use
- D. Distracted driving

Associated factors:

- E. Impulsivity
- F. Risk perception
- G. Protective beliefs (control beliefs, normative beliefs)

We will also gather data on frequency of driving and types of trips (i.e., purpose, length, type of roadway, and geography).

Participants will be offered feedback regarding the scales as a benefit of participation and will also be compensated with a gift card for participation.

**Table 5. Timeline for Each Participant**

	<b>Week 0</b>	<b>1</b>	<b>2</b>	<b>3-4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8-19</b>	<b>20</b>
Intervention	Recruitment and screening	Consent, randomize, baseline assessments	Module 1	Mod 1 practice (and texts)	Module 2	Mod 2 practice (and texts)	Post assessments	* 3 months pass	Follow-up assessments
Control			No treatment						

The total number of participants will be determined with a priori power analysis. Preliminary power analyses suggest a total final sample of 172 participants is necessary for 80% power to detect a small-to-moderate effect (partial  $\eta^2 = .03$ ) with  $\alpha \leq .05$  and a .5 correlation between measurements. We will confirm this power analysis during piloting. Additionally, we anticipate participant attrition, which will require us to over recruit to ensure an adequate final sample size.

## 6.4 Hypotheses

We hypothesize that:

1. The brief intervention will result in reduced impulsivity, increased risk perception, and increased protective beliefs.
  - a. Compared to participants in the control group, participants in the intervention group will have greater reductions in impulsivity scores.
  - b. Compared to participants in the control group, participants in the intervention group will have increases in risk perception and other protective beliefs.
2. The brief intervention will, through reduced impulsivity and/or increased risk perception and protective beliefs, result in participants engaging in fewer high-risk driving behaviors.
  - a. Compared to participants in the control group, participants in the intervention group will report fewer high-risk driving behaviors at follow up. Reductions in high-risk driving behavior will be associated with reduced impulsivity and increased risk perceptions or protective beliefs.

## 6.5 Planned Analysis

The primary analysis will be a repeated measures multiple analysis of variance (MANOVA) with the intervention identified as a between factor. MANOVA is the appropriate main analytical test for both hypotheses and will allow us to test the effect of the intervention on impulsivity, risk perceptions, beliefs, and the four driving behaviors. We will conduct additional correlations and/or regressions to understand the relationship between the variables (e.g., the relationship between impulsivity and driving behaviors).

## 7 CONCLUSIONS

Drivers involved in fatal crashes are often engaged in multiple risky behaviors – not wearing a seat belt, speeding, and driving impaired (FARS, 2018). Brief interventions designed to address multiple risky behaviors have the potential to improve driving safety (Sommers et al., 2014). In this Task 1 report, a summary of literature regarding factors associated with multiple risky driving behaviors was provided. Factors include cognitive factors, affective factors, motivational factors, and contextual factors. Many of these factors that affect risky driving must be considered in combination as they overlap and are related to one another (Al-Tit, 2020; Bachoo et al., 2013; Iversen & Rundmo, 2002). An intervention that seeks to address multiple risky driving behaviors will need to consider the influence of these factors.

In this summary of literature, specific behavioral interventions that addressed specific high-risk driving behaviors and associated factors were reviewed. Specifically, behavioral interventions to reduce speeding, impaired driving, seat belt use, and distracted driving were reviewed along with interventions that address factors associated with multiple risky driving behaviors. Behavioral interventions are gaining popularity, and lessons about these interventions to address specific high-risk driving behaviors in isolation can be learned and used to inform the development of an intervention to reduce multiple risky driving behaviors.

Finally, as this project includes both designing and implementing an intervention to reduce multiple risky driving behaviors, various delivery methods were explored including mobile health technologies, brief interventions, and vehicle safety monitoring systems.

In addition to a review of literature, this Task 1 report included outlines to support the development, implementation, and evaluation of the brief intervention proposed for this project. In the next task (Task 2), content will be created to reach drivers who engage in multiple risky behaviors.

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